

[0042] In such case, the body data recorded at the outset, at least those of the workpieces, are virtually adjusted.

[0043] Furthermore, the task is solved by using a virtual sensor to determine the condition of a tool holder, such as a spindle, or a tool machine which can be operated using a process with at least one of the aforementioned characteristics and work steps, with at least one tool holder, with at least one tool attached or attachable to the tool holder, by means of which a workpiece can be processed by running a machine program, and with at least one control unit comprising at least one sensor which can be used to measure time-dependent, total real energy intake and to calculate time-dependent, total virtual energy intake, whereby the radial forces acting on the tool holder can be calculated using the control unit at least as the difference between total real energy intake and time-dependent, total virtual energy intake.

[0044] Finally, the task is solved by a tool machine which comprises at least one virtual sensor with at least one of the aforementioned characteristics, and/or which can be operated using a process with at least one of the aforementioned characteristics or steps.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0045] Further characteristics, details and advantages of the invention can be found in the enclosed patent claims, the graphic illustration, and the following description of preferred embodiments of the process.

[0046] The illustration shows:

[0047] FIG. 1 A schematic sideview of a virtual sensor of a tool machine;

[0048] FIG. 2 A schematic flow chart of a process according to the invention.

#### DETAILED DESCRIPTION OF THE INVENTION

[0049] FIG. 1 shows a schematic sideview of a virtual sensor labelled as a whole with reference numeral 2. This serves to define the condition of a tool holder 4, such as a spindle, clamp, grip, etc., of a tool machine 6 (only partial area presented in FIG. 1). The tool machine 6 comprises the tool holder 4 and also a tool 8 which allows a workpiece 10 to be processed by running a machine program stored in a control unit 12. Moreover, the tool machine 6 comprises at least one sensor 16 which allows time-dependent, real total energy intake, e.g., an ammeter, voltmeter, electrical or power measurement systems, etc., to be recorded by the virtual sensor 2 and to be calculated using time-dependent, virtual total energy intake.

[0050] FIG. 2 shows a schematic flow chart. The process for operating a virtual sensor 2 for determining the condition of a tool holder 4 of a tool machine 6 is described below under reference to the components of the tool machine 6 depicted in FIG. 1. A machine program can be run on the tool machine 6. Here, the process comprises an initial step 100, in which in particular a time-dependent piece of body data of the workpiece 10, of the tool 8, of the tool holder 4, and/or of at least one drive axle 14 can be recorded. This piece of body data may relate to a material and/or geometry, for example. In particular, the recorded geometry of the body data for the tool 8 and/or the tool holder 4 can be approximated in the step 100 using virtual auxiliary geometry from a number of N auxiliary elements, and/or the geometry of

the workpiece 10 can be approximated using a virtual scatter plot in a Cartesian coordinate system, the individual points of which are spaced at regular intervals from one another and which, in particular, form a regular matrix.

[0051] In a subsequent step 101, the time-dependent room data of the workpiece 10, of the tool 8, of the tool holder 4, and/or of at least one drive axle 14 are recorded. The room data may comprise a position and/or orientation relative to an initial coordinate origin of the tool machine, for example.

[0052] In a subsequent step 102, at least one piece of time-dependent operating data, such as feed speed, RPM or rotational speed of the tool holder 4, and/or at least one electrical current, in particular one generating a moment, of the tool holder 4 and/or of at least one drive axle 14 can be recorded. By recording the feed speed, it is possible to additionally record a time interval—in step 102, for example—within which the steps to be performed in the process are repeated. The time interval is calculated such that the distance between two points comprises the geometry of the workpiece 10 approximated as a virtual scatter plot, divided by the feed speed of the tool 8 and/or of the tool holder 6. This allows the accuracy of the process to be improved.

[0053] Moreover, the time-dependent real total energy intake of one or more steps in the machine program can be recorded in a further step 103 using at least one of the control unit's 12 sensors 16, and the time-dependent, virtual total energy intake of one or more steps can be calculated using a virtual simulation of the machine program with the control unit 12 based on the body data, room data, and operating data recorded. For example, as well as the data recorded and calculated, calibration can be optimized by means of a machine-specific calibration factor, and/or multiplication of the virtual, time-dependent energy intake calculated for workpiece processing can be optimized by means of a material constant or material variable.

[0054] In a subsequent step 104, the radial forces acting on the tool holder 4 can be recorded or calculated, at least as the difference between time-dependent real total energy intake and time-dependent virtual total energy intake with the control unit 12.

[0055] Such information from the virtual sensor is then used to estimate the condition of the workpiece, tool, toolholder, etc., in order to adjust the processing of the workpiece and removal of the same when complete.

[0056] The characteristics of the invention disclosed in the above description, in the claims, and in the illustration may be essential both individually and in any combination to the realization of the invention in its various embodiments.

#### LIST OF REFERENCE NUMERALS

[0057]	2 Virtual sensor
[0058]	4 Tool holder
[0059]	6 Tool machine
[0060]	8 Tool
[0061]	10 Workpiece
[0062]	12 Control unit
[0063]	14 Drive axle
[0064]	16 Sensor
[0065]	100—
[0066]	104 Process steps

1. A process for operating a virtual sensor for determining the condition of a tool holder on a tool machine and the condition of a tool machine which has at least one tool